

# JAPAN

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JIS Z 9123 (1997) (English): Lighting for  
outdoor, indoor swimming pools

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*The citizens of a nation must  
honor the laws of the land.*

Fukuzawa Yukichi

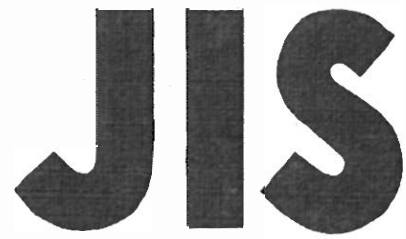
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JAPANESE  
INDUSTRIAL  
STANDARD

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JIS Z 9123 : 1997

Lighting for outdoor, indoor  
swimming pools

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ICS 91.160.01; 97.220.10

**Descriptors** : swimming pools, sports facilities, lighting systems, lighting levels

**Reference number** : JIS Z 9123 : 1997 (E)

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## Lighting for outdoor, indoor swimming pools

**1 Scope** This Japanese Industrial Standard specifies lighting for outdoor and indoor swimming pools.

Remarks : The following standards are cited in this Standard:

JIS C 1609 *Illuminance meters*

JIS C 7612 *Illuminance measurements for lighting installations*

JIS Z 8113 *Glossary of lighting terms*

**2 Definitions** For the purpose of this Standard, the definitions specified in JIS Z 8113 and the following definition apply.

**$\frac{1}{2}$  illuminance angle** When horizontal plane is illuminated by the light distribution with vertical reference axis, this means the angle made by the downward reference axis and a straight line connecting the point on the plane where the horizontal illuminance is  $\frac{1}{2}$  of that at a point directly under the light center.

### 3 Requirements for execution of lighting

**3.1 Investigation items** The following items shall be investigated at planning the lighting:

- (1) **Structure of facilities** The following matters shall be taken into account.
  - (a) Distinction of outdoor facilities from indoor facilities, shape and dimensions of facilities, whether stands or fences are installed or not, and so on.
  - (b) In the case of indoor facilities, condition of window, and material, color, reflectance of ceiling, wall and field surface.
  - (c) In the case of outdoor facilities, material, color, reflectance, etc. of field surface.
  - (d) If stands or fences are installed, their material, color, reflectance, etc.
  - (e) Places where luminaires are able to be provided or the like.
- (2) **Details in utilization** Distinction of athletic sports or recreation and whether the sports are televised or not.
- (3) **Environments of facilities** For outdoor installation, whether residential areas, roads, railroads, airports, etc. exist in the vicinity or not, and the positional relationship, if exist.
- (4) **Meteorological conditions** For outdoor installation, conditions of snowfall, salt mist, wind speed, etc.
- (5) **Power supply conditions** Electrical system, service voltage, frequency, power capacity, etc.

**3.2 Design of lighting** The following items shall be taken care of at the design of lighting:

- (1) **Illuminance and its uniformity ratio** Enough illuminance shall be given to the field surface, and good uniformity ratio shall be maintained.
- (2) **Glare** In order to avoid the occurrence of serious trouble, attention shall be paid so as to decrease the direct glare from the luminaire and the reflection glare on the water surface as far as possible.
- (3) **Stroboscopic phenomenon** When discharge lamps are operated at a commercial frequency (50 Hz or 60 Hz), the stroboscopic phenomenon shall be minimized as far as possible.
- (4) **Light source** Adequate light sources shall be selected by taking the following items into consideration:
  - (a) Luminous efficacy of the lamp (overall efficacy including ballast loss, for discharge lamps)
  - (b) Life and luminous flux maintenance factor
  - (c) Light source color and color rendering properties
- (5) **Others** The following items shall be taken into consideration:
  - (a) Selection of materials and method for installation work to meet the natural environment.
  - (b) Easy maintenance and control
  - (c) Economical property
  - (d) Fine view
  - (e) Safety lighting
  - (f) Spare circuits

## **4 Standard of lighting**

### **4.1 Lighting for outdoor pools**

**4.1.1 Lighting range** The lighting range shall be the whole pool including the pool sides surrounded by fences or spectator stands.

**4.1.2 Illuminance and its uniformity ratio** The illuminance and its uniformity ratio shall have the relevant values given in Table 1, on the surfaces of water and on the floor of pool sides.

The measuring method of illuminance shall be as specified in Annex.

**Table 1** Average value of illuminance and uniformity ratio of horizontal illuminance<sup>(1)</sup>

Classification	Horizontal illuminance		Vertical illuminance <sup>(6)</sup>
	Average value lx	Uniformity ratio <sup>(5)</sup>	Average value lx
Official sport <sup>(2)</sup>	1 000 min.	0.50 min.	200 min.
Unofficial sport <sup>(3)</sup>	500 min.		
Recreation <sup>(4)</sup>	200 min.	0.40 min.	—

Notes (1) If there are differences in height between water surface and the floor surfaces of pool sides, a supposed horizontal plane having a height equal to the height of the floor surface of pool side closest to the water surface is taken, and the illuminance and uniformity ratio may be obtained on this plane over the whole range of lighting.

(2) Sport whose results are maintained as official records

(3) Sport other than official sport

(4) Swimming for leisure and increasing health, exercise and play in pool

(5) The uniformity ratio of horizontal illuminance is expressed by the following formula (1):

$$Uh = \frac{Eh_{\min}}{Eh_{\text{ave}}} \dots\dots\dots (1)$$

where,  $Uh$  : uniformity ratio of horizontal illuminance

$Eh_{\min}$  : minimum value of horizontal illuminance (lx)

$Eh_{\text{ave}}$  : average value of horizontal illuminance (lx)

(6) The vertical illuminance is applied to diving pools only. The value of illuminance, in the direction of both sides of pool, at the space where the exercise in air is carried out (including a height up to 3 m above the springboard) is shown.

Remarks : For the illuminance and its uniformity ratio for television photographing, 5 shall be referred to.

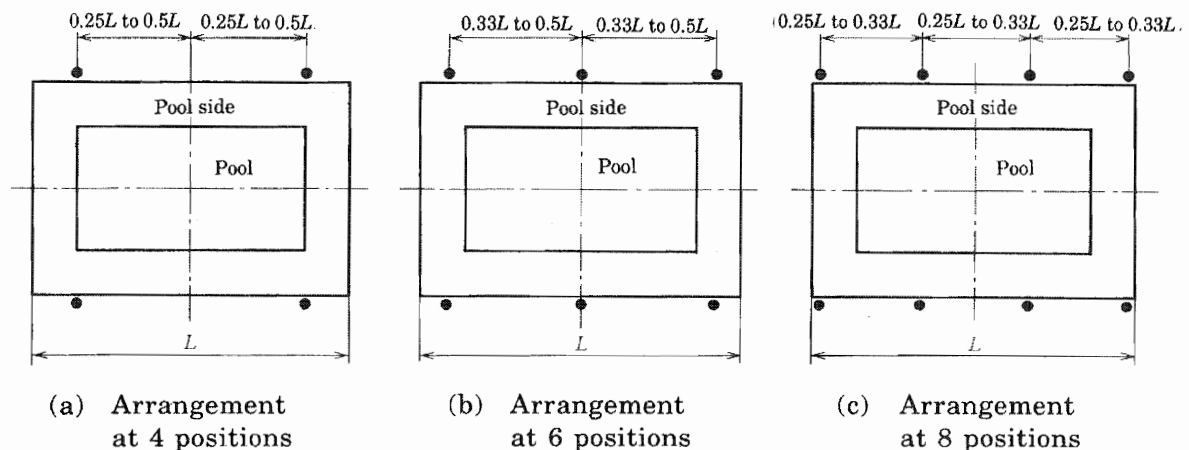
**4.1.3 Lighting system** Floodlighting system from the pool sides shall be employed.

**4.1.4 Arrangement of luminaires** The arrangement of luminaires shall be so determined that no dark place appears in the lighting range. However, for rectangular pools for sport, the arrangement shall be as given in Table 2 and Fig. 1.



**Table 2** Arrangement of luminaires

Classification	Arrangement of luminaire	
	For 25 m pool	For 50 m pool
Official sport <sup>(2)</sup>	Arrangement at 6 positions	Arrangement at 8 positions
Unofficial sport <sup>(3)</sup>		
Recreation <sup>(4)</sup>	Arrangement at 4 positions	Arrangement at 6 positions



Remarks 1 The  $L$  indicates the overall length in lengthwise direction of lighting range.

2 The ● indicates the set position of luminaires.

**Fig. 1** Examples of arrangements of luminaires

**4.1.5 Attaching height of luminaires** The attaching height of luminaires at the lowest stage shall be determined from the formula (2), formula (3) and Fig. 2. The attaching height shall be not less than  $\frac{1}{4}$  of the interval between the luminaires.

(1) If there are spectator stands

$$H_1 \geq 0.8W - d \quad (2)$$

(2) If there are no spectator stands

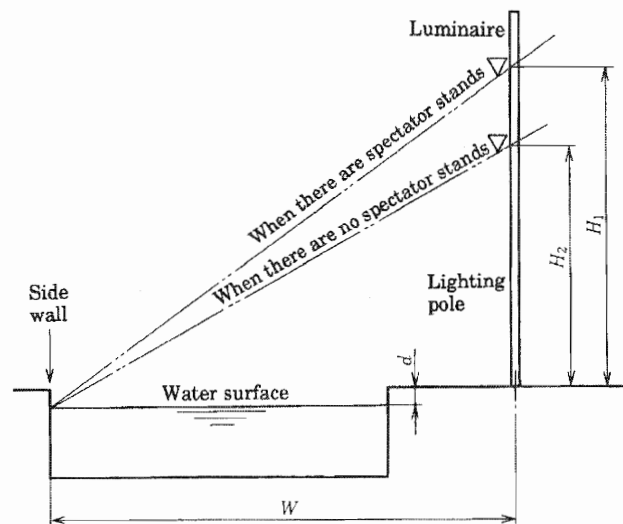
$$H_2 \geq 0.6W - d \quad (3)$$

where,  $H_1$ : attaching height of luminaires at the lowest stage when there are spectator stands (m)

$H_2$ : attaching height of luminaires at the lowest stage when there are no spectator stands (m)

$W$ : horizontal distance from the center of lighting pole to the side wall of pool on the opposite side (m)

$d$ : difference in height between water surface and installation position of lighting pole (m)



**Fig. 2** Attaching height of luminaires  
(for outdoor pool)

**4.1.6 Luminaires** The luminaires shall be outdoor floodlights, and shall be selected according to Table 3.

**Table 3** Selection of luminaires

Classification	Classification of distribution of luminous intensity of floodlight		
	Narrow angle type <sup>(7)</sup>	Medium angle type <sup>(8)</sup>	Wide angle type <sup>(9)</sup>
Official sport <sup>(2)</sup>	○	⊙	○
Unofficial sport <sup>(3)</sup>	○	⊙	○
Recreation <sup>(4)</sup>	○	○	⊙

Notes (7) That of beam divergence angle (up to  $\frac{1}{10}$  of the maximum luminous intensity) is less than 30°

(8) That of beam divergence angle of 30° or more to and excl. 60°.

(9) That of beam divergence angle of 60° or more.

Remarks : Mark ⊙ indicates luminaires to be used mainly and ○ indicates those to be used as needed.

## 4.2 Lighting for indoor pool

**4.2.1 Lighting range** The lighting range shall be the whole pool including the pool sides surrounded by walls or spectator stands.

**4.2.2 Illuminance and its uniformity ratio** The illuminance and its uniformity ratio shall have the relevant values given in Table 1, on the surfaces of water and on the floor of pool sides.

The measuring method of illuminance shall be as specified in Annex.

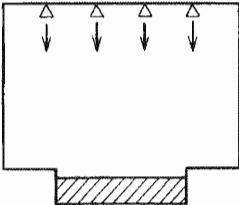
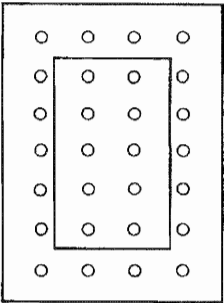
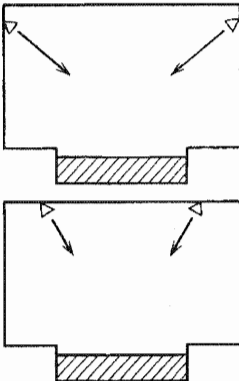
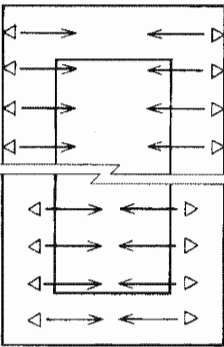
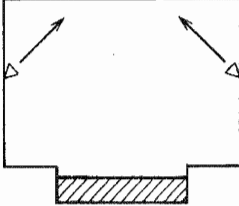
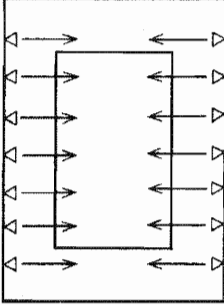
**4.2.3 Lighting system** The direct lighting system or indirect lighting system shall be employed.

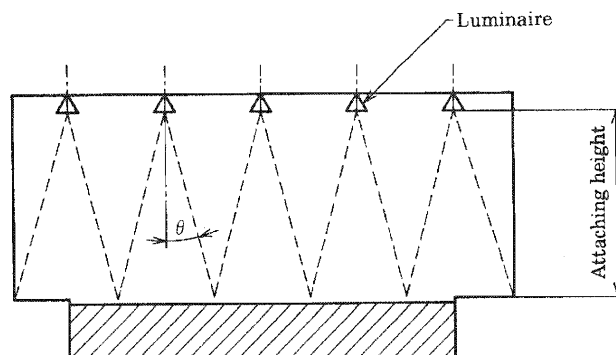
**4.2.4 Arrangement of luminaires** The arrangement of luminaires shall be selected from Table 4.

**4.2.5 Attaching interval and attaching height of luminaires**

- (1) The attaching interval of luminaires in dispersed arrangement shall, as shown in Fig. 3, be within a range in which  $\frac{1}{2}$  illuminance angle is satisfied on the field surface.

**Table 4** Arrangement of luminaires

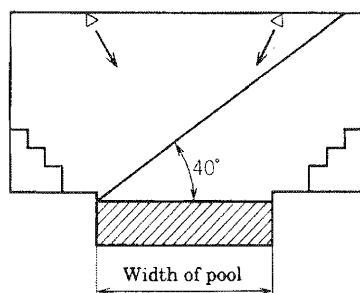
Lighting system	Arrangement of luminaires		Example of arrangement of luminaires		Selecting conditions
			Sectional view	Plan	
Direct lighting system	Dispersed arrangement	Luminaires are arranged being dispersed over the whole ceiling.			When the maintenance work can be done from the ceiling side.
	Side arrangement	Luminaires are arranged linearly on the walls above the pool sides or ceiling (those above water shall be avoided) and the irradiation is made slantwise and downward.			When the maintenance work can not be done from the ceiling side.
Indirect lighting system	Side arrangement	Luminaires are arranged linearly on the walls above the pool sides and the irradiation is made slantwise and upward.			When the ceiling surface is a high diffuse reflection surface.



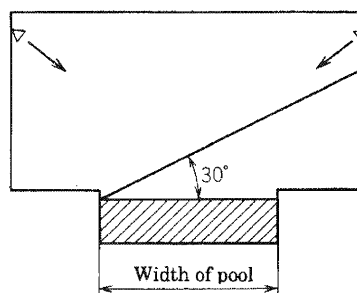
Remarks :  $\theta$  indicates  $\frac{1}{2}$  illuminance angle.

**Fig. 3** Attaching interval of luminaires in dispersed arrangement

- (2) The attaching height of luminaires in direct lighting system arranged at the sides shall be such that the location is above the angle shown in Fig. 4.



Where there are spectator stands



When there are no spectator stands

**Fig. 4** Attaching height of luminaires (for indoor pool)

- (3) The attaching height of luminaires in indirect lighting system arranged at the sides shall be at least 2.3 m above the floor so that the luminaires are not easily accessed by a man.

**4.2.6 Luminaires** The luminaires shall be floodlights, reflectors or such a device that the above apparatus are contained in an enclosure. The structure shall have waterproof performance of at least drip proof type, and the materials and the finish shall be protected against moisture, chlorine, etc.

### 4.3 Underwater lighting

**4.3.1 Lighting range** The lighting range shall be the space in the water surrounded by the side walls of the pool body.

**4.3.2 Luminous flux** The incident luminous flux into water shall have the relevant value given in Table 5.

**Table 5** Luminous flux to be introduced in water

Classification	Luminous flux <sup>(10)</sup> lm
Official sport <sup>(2)</sup>	1 500 to 1 000
Unofficial sport <sup>(3)</sup>	1 000 to 600
Recreation <sup>(4)</sup>	

Note <sup>(10)</sup> Per horizontal area 1 m<sup>2</sup> of water surface.

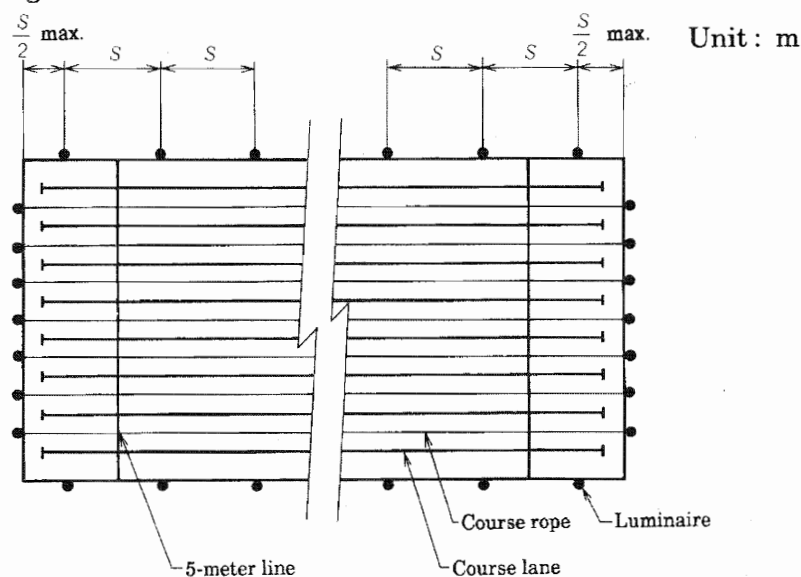
**4.3.3 Luminaires** The luminaires shall be floodlights. If installed in water the luminaires shall be submersible type.

It is recommended that the distribution of luminous intensity is the narrow angle type.

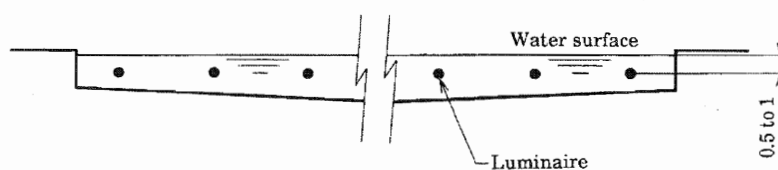
**4.3.4 Arrangement of luminaires** The luminaires shall be arranged on the walls of pool body. When luminaires are installed on the end walls, the position shall be the same as that of the course rope between courses.

The interval and depth of mounting luminaires shall be as illustrated in Fig. 5.

(1) Attaching interval



(2) Attaching depth



Remarks : *S* indicates the attaching interval in longitudinal direction, and the length shall be not more than 5 m.

**Fig. 5** Arrangement of luminaires

## 5 Standard of lighting for television photographing

**5.1 Illuminance and its uniformity ratio** The illuminance and its uniformity ratio shall have the relevant values given in Table 6.

The measuring method of illuminance shall be as specified in Annex.

**Table 6** Average value of illuminance and uniformity ratio

Classification of illuminance	Average value lx	Uniformity ratio <sup>(11)</sup>
Vertical illuminance <sup>(12)</sup>	1 000 min.	0.30 min.
Horizontal illuminance <sup>(13)</sup>		0.50 min.

Notes <sup>(11)</sup> The uniformity ratio is expressed by the formula (4) and formula (5).

$$\text{Uniformity ratio of vertical illuminance } U_v = \frac{E_{v_{\min}}}{E_{v_{\max}}} \dots\dots\dots (4)$$

where,  $U_v$  : uniformity ratio of vertical illuminance

$E_{v_{\min}}$  : minimum value of vertical illuminance (lx)

$E_{v_{\max}}$  : maximum value of vertical illuminance (lx)

$$\text{Uniformity ratio of horizontal illuminance } U_h = \frac{E_{h_{\min}}}{E_{h_{\max}}} \dots\dots\dots (5)$$

where,  $U_h$  : uniformity ratio of horizontal illuminance

$E_{h_{\min}}$  : minimum value of horizontal illuminance (lx)

$E_{h_{\max}}$  : maximum value of horizontal illuminance (lx)

<sup>(12)</sup> The vertical illuminance on the camera side of the space 1.5 m above the pool side and the space where the exercise in air is done in diving pool (including a height 3 m above the springboard).

<sup>(13)</sup> Horizontal illuminance at the pool side and pool water surface.

Informative reference : Lighting of spectator stands : It is recommended to maintain the vertical illuminance at pool side adjacent to spectator stands facing to the camera side at approximately 0.25 times the value specified in Table 6.

**5.2 Decreasing of flicker** When discharge lamps are used, such a means shall be employed as connection with three-phase power supply, to decrease the flicker which appears on the television technical drawing.

**5.3 Light source color and color rendering properties** The light source color and the color rendering properties shall have the relevant values given in Table 7.

**Table 7** Light source color and color rendering properties

Light source color	Range of 6 000 K to 3 000 K in color temperature
Color rendering properties	General color rendering index of at least 55

**6 Maintenance and control** For the maintenance and control of lighting installation, the works prescribed below shall be carried out periodically.

- (1) Checking of burning condition
- (2) Replacement of lamps
- (3) Replacement of ballast (separate type only)
- (4) Cleaning
- (5) Checking of luminaires
- (6) Checking and repair of lighting poles
- (7) Checking and repair of wiring and switching devices
- (8) Measurement (according to Annex) and record of illuminance

## Annex Measuring methods of illuminance

**1 Scope** This Annex specifies measuring methods for horizontal illuminance and vertical illuminance of swimming pools.

General rules for measurement of illuminance other than those specified in this Annex are given in **JIS C 7612**.

The illuminance meter to be used shall be that of general class AA specified in **JIS C 1609** or those equivalent or superior thereto in performance.

## 2 Measuring method of illuminance

**2.1 Measuring range** The measuring range shall be the whole of the pool including the pool side surrounded by fence, wall or spectator stands.

**2.2 Measuring points** The measuring points shall be the points of intersection of dividing lines when the measuring range is divided into the same areas as illustrated in Annex Fig. 1, and the interval shall be 3 m to 5 m.

**2.3 Measurement of horizontal illuminance** The measurement of horizontal illuminance shall be carried out at the measuring points shown in 2.2 at a height of not more than 15 cm above the floor surface or the water surface.

**2.4 Average value of horizontal illuminance** The average value of horizontal illuminance shall be calculated by the formula (1).

$$Eh_{ave} = \frac{1}{4N} \left( \sum_{i=1}^4 E_{\square i} + 2 \sum_{i=1}^n E_{\triangle i} + 4 \sum_{i=1}^o E_{\bigcirc i} \right) \dots\dots\dots (1)$$

where,  $Eh_{ave}$ : average value of horizontal illuminance

$E_{\square}$ : illuminance at corner point

$E_{\triangle}$ : illuminance at side point

$E_{\bigcirc}$ : illuminance at inner point

$n$ : number of side points

$o$ : number of inner points

$N$ : number of blocks surrounded by dividing lines

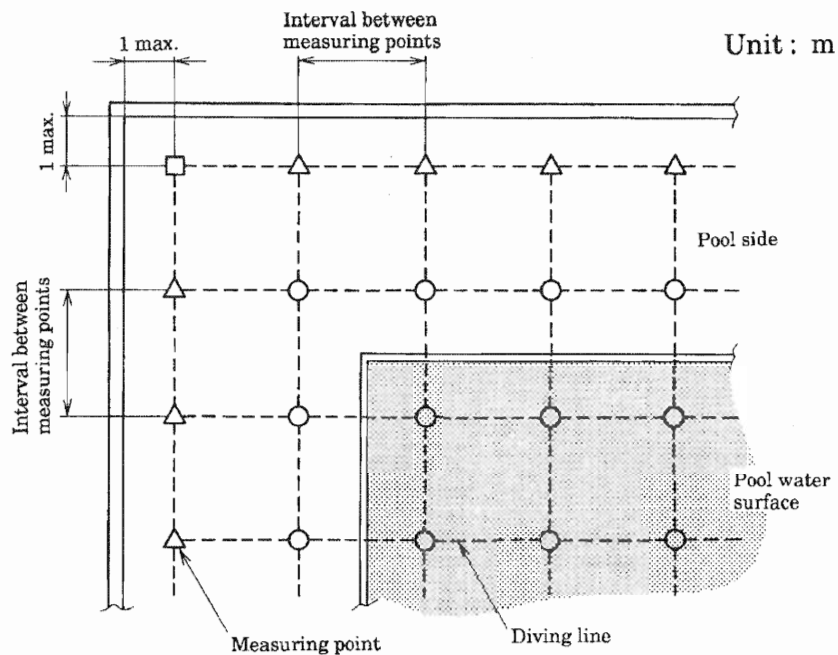
**2.5 Measurement of vertical illuminance** In the sports field where television picture is taken, the measurement of vertical illuminance shall be carried out at the measuring points of pool sides shown in 2.2 at a height of 1.5 m above the floor surfaces. The vertical illuminance shall be measured in the four directions illustrated in Annex Fig. 2 and the object to be estimated shall be the direction toward the main camera. The measuring method of vertical illuminance of the space where exercise in air is carried out in a diving pool is not specified.

The average value of vertical illuminance shall be the value obtained by simply averaging the measured values in each direction.



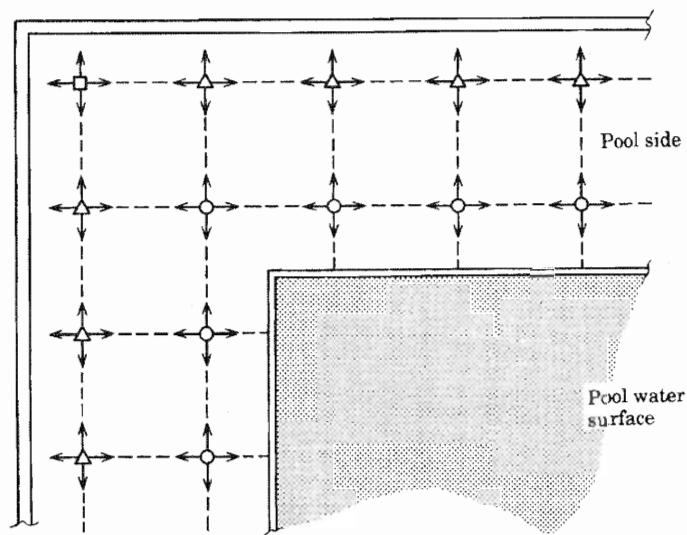
## **2.6 Omission of measuring points**

- (1) If both the lighting installation and the measuring range are symmetrical with respect to the center line, the measurement may be carried out on one of the symmetrical areas with the measurement on the other part omitted.
- (2) When the data are used as informative references for maintenance and control, the overall tendency of illuminance may be estimated by measuring the illuminance at several points on the pool side.



Remarks : The figure shows a part of measuring range.

**Annex Fig. 1** Measuring points of illuminance



Remarks 1 The → shows the direction of the light receiving surface of the illuminance meter.

2 The figure shows a part of measuring range.

**Annex Fig. 2** Measuring directions of vertical illuminance

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